# CENTRAL RICE RESEARCH INSTITUTE, CUTTACK – 4

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## ANNUAL REPORT FOR 1951-1952

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# CENTRAL RICE RESEARCH INSTITUTE
# CUTTACK-4, ORISSA

## Annual Report for 1951-52

*Weather and crop conditions.*—The 1951-52 season was favourable for the rice crop and the yields obtained were satisfactory. Pre-monsoon showers, amounting to 4 inches, received during the month of May facilitated the preliminary agricultural operations, and with the outbreak of South-West monsoon in time and the good distribution of the 68·97″ of rain received over the main crop season, the sowing, planting and intercultural operations could be done in time. The rainfall during the winter months was, however, deficient and the yield of the second crop was adversely affected.

## AGRONOMY

### A. Varietal Trials

Five trials, with 70 strains, brought forward from the previous trials and observation plots, were conducted both under manured and unmanured conditions.

(i) In the 85—100 days trial 4 Chinese, 2 new selections and 4 local varieties were tested. The two selections B. 76-1 and B. 76-3, outyielded all the others, giving 11·3 and 6·8 per cent better yield respectively than the control (*Benibhog*). However, these two selections proved to be 8--10 days later than the parental material. The rest of the varieties included in the trial yielded less than the control, China 45 being the best among these. The Chinese varieties will be further tested next year.

(ii) In the 100—110 days trial 15 varieties were tested. Varieties Adt 20 and two Chinese varieties, *viz.*, Ch. 54 and Ch. 63 gave 28·4, 14·9 and 8·7 per cent higher yield than the control *Benibhog*. Varieties Adt 4, Ptb 10 and Co. 21 which were found superior to *Benibhog* last year proved as good as the control this year.

(iii) In the 110—125 days duration trial 16 varieties were tested. Seven of these varieties yielded significantly better than the control T608. The most promising ones were found to be Ptb2, Ptb8 and Ptb13. The last named variety gave the highest yield, being 55·6 per cent better in yield than the control. Variety Adt. 9, which was last year reported better in yield than T608, gave 11·2 per cent more than the control this year. Variety Adt 15, reported as superior to *Benibhog* last year, was found to be longer in duration than *Benibhog* and hence was compared against T608 in this trial. It proved inferior in yield to T608.

(iv) The 125—140 days duration trial was conducted with 16 varieties, which included varieties SLO6, SLO9 and BAM-1. Last year

the first two varieties were found as good as the control T1145, while BAM-1 was found to yield 27·7 per cent better than T1145. While SLO6 and SLO9 were again found to be as good as T1145 this year and BAM-1 yielded 16·5 per cent better, the best performance was recorded by varieties T874-1-9-2, T1233 and T588, which yielded 27·6, 27·8 and 36·2 per cent better respectively than T1145. These 3 varieties had performed well in the preliminary yield trials in the previous years but they are 10-12 days later in duration than T1145. Another variety, *viz.*, T141, in this trial out-yielded the control by 20·7 per cent.

(v) In the late duration trial 10 varieties were tested against the control T1242. None of the varieties under trial proved superior to T1242. However, two varieties BAM-9 and BAM-6, proved as good as T1242 in yield, these two varieties yielded last year about 20 per cent better than T90, a fine grained local improved variety.

*Manures and varieties.*—The above varietal trials, as has been mentioned, were conducted under both manured and unmanured conditions. The results obtained this year, as well as in the previous years, show that while the magnitude of the response to manuring varies from season to season, the relative performance of the varieties remains more or less constant. The available data does not show any differential response of the varieties to manuring and the improved varieties generally maintain their superiority both under manured and unmanured conditions.

## B. Cultural Trials

*Crop sequence experiment.*—The sequence followed in this experiment was:—

(i) groundnut in *kharif* season followed by rice in winter;

(ii) rice in *kharif* season followed by rice in winter.

In the first sequence the rice yield obtained was 1118 lb. per acre compared to 741 lb. of the winter rice obtained with the second sequence, thus giving a 51 per cent increase in yield of rice in the winter season. This confirms the findings of the previous years. Groundnut was sown as winter crop during the year recording a yield 2044 lb. per acre. The effect of this crop on the yield of rice in *kharif* season will be tested next year.

## C. Manurial Trials

(i) *Efficiency of different nitrogenous fertilizers for rice.*—This is the 3rd year of the experiment. It included, as in the previous years, nitrogenous fertilizers in the shape of ammonium sulphate, ammonium nitrate, ammonium phosphate and urea at 20 and 40 lb. N per acre tested on 3 varieties of different durations.

The results show that all the varieties responded more or less to the same extent at both levels to ammonium salts, while with urea the response was significantly lower. In the previous year response to

ammonium sulphate was found to be slightly better. The response of the varieties, though not high, was found to be linear.

The results obtained are summarised below:—

| Level of N lb. per Acre | Yield in lb. per Acre: Ammonium sulphate | Ammonium Nitrate | Ammonium phosphate | Urea | Mean | C.D. 5% |
|---|---|---|---|---|---|---|
| 20 | 2090 | 2032 | 2084 | 1998 | 2051 | 71·5 |
| 40 | 2029 | 2217 | 2991 | 2110 | 2187* | |
| Mean | 2159 | 2124 | 2142 | 2052 | | |
| C.D. 5% | 110·8 | | | | | |

(ii) *Comparison of the method of application of ammonium sulphate in wet and dry soil conditions.*—The investigation, which has been in progress for the last two years, was modified to include additional treatment at 40 lb. N per acre, in addition to the treatment 20 lb. N per acre used previously. The application of the fertilizer was done in 3 instalments, *viz.*, at planting, one month after planting and before flowering. As in previous years, in both types of land (medium and low), dry and deep application of the fertilizer before transplanting gave better response than wet application on the surface after transplantation. Splitting of the fertilizer application in 3 doses did not give better response than application of the entire dose at one time in dry condition of the soil. The three years data have shown the superiority of dry application over the wet surface application. Dry application has also given more consistent response. Increasing the level of N from 20 to 40 lb. has generally resulted in increased yields. The results of the last three years are summarised in the table below:—

*Average of* 3 *years* (1949—52) *yield in lb. per acre*

| Control (no manure) | Wet surface application (20 lb. N/A) | Dry surface application (20 lb. N/A) |
|---|---|---|
| 1801 | 1985 | 2080 |
| Increase in yield lb./A. | 184 | 279 |
| Relative efficiency | 100 | 151·6 |
| | S. E. 27·5 | |
| | C. D. 77·0 | |

(iii) *Combination of organic (green manure) and inorganic (ammonium sulphate) fertilizer.*—Relative efficiency of green manuring, fertilizing with ammonium sulphate and combination of the two are under study in this investigation. The experiment this year was carried out with same layout and treatments as last year.

The results obtained show that with the application of ammonium sulphate, increased yields were obtained upto the level of 20 lb. N per acre, and with further increase in the dose of the fertilizer there was practically no increase in yield. With green manure, increased yield was obtained at 10 lb. N, while there was no increase with further increased doses. In the previous year increased yields were obtained upto 20 lb. N level. The application of ammonium sulphate over green manure, as the previous year, did not give additional response. The data are summarised below:—

*Ammonium sulphate (top dressing)*

| Green manure (Basal dressing) | Levels of N/A | 0 | 10 | 20 | 30 | Mean | C.D. |
|---|---|---|---|---|---|---|---|
| | 0 | 2328 | 2516 | 2752 | 2708 | 2556 | 80·54 |
| | 10 | 2845 | 2789 | 2845 | 2807 | 2821 | |
| | 20 | 2700 | 2778 | 2776 | 2890 | 2786 | |
| | 30 | 2684 | 2749 | 2781 | 2697 | 2727 | |
| | Mean | 2634 | 2708 | 2788 | 2775 | | |
| | C. D. | 80·54 | | | | | |

(iv) *Combination of organic (compost) and inorganic (ammonium sulphate) fertilizer.*—This new experiment was undertaken with a view to investigating the effect of applying varying doses of compost alone and with ammonium sulphate as top dressing in varying doses. Compost was applied at 4 levels, *viz.*, 0, 30, 60 and 90 lb. N/A and ammonium sulphate at 0, 15 and 30 lb. N/A. The results obtained showed no significant increase in yield with the application of compost or ammonium sulphate. This is most probably due to the high fertility of the plot, the control plot yielding 3136 lb. per acre.

(v) *Continuous manurial trials.*—As has been previously reported these experiments are being conducted to study the cumulative effect of continuous application of the fertilizer, ammonium sulphate, on soil condition and productivity, and whether addition of compost or lime had any ameliorative effect.

(a) *Ammonium sulphate with and without lime.*—This is the 4th year of the experiment and was conducted with the

same layout and treatments as in the previous years. The data are presented in the table below:—

*Yield in lb. per acre*

| Lime Cwt. acre | Ammonium sulphate N/A 0 | 20 | 40 | Mean | C.D. |
|---|---|---|---|---|---|
| 0 | 2435 | 2582 | 2779 | 2599 | 122·6 |
| 4 | 2376 | 2440 | 2664 | 2493 | |
| 8 | 2348 | 2560 | 2708 | 2539 | |
| Mean | 2386 | 2527 | 2717 | | |

As in previous years, there was no effect of lime either alone or in combination with ammonium sulphate. The response to the application of ammonium sulphate was linear. There was no decrease in response in the treatment plots where ammonium sulphate was applied continuously to the plots during the past 4 years.

(b) *Ammonium sulphate with and without compost.*—This is a parallel experiment to the previous one and has been in progress for the past 3 years with same layout, treatments and plots as has already been reported. The results obtained this year are given below:—

*Yield in lb. per acre*

| Levels of N/A | No compost | Compost 100 mds./A | Mean | C.D. |
|---|---|---|---|---|
| 0 | 1988 | 2319 | 2154 | 224·3 |
| 20 | 2339 | 2361 | 2350 | |
| 40 | 2395 | 2155 | 2275 | |
| 60 | 2355 | 2077 | 2216 | |
| 80 | 1999 | 1364 | 1682 | |
| Mean | 2215 | 2055 | | |
| C. D. | 353·4 | | | |

The results show that nitrogen in the form of ammonium sulphate when applied to non-compost plots at 20 lb. N/A increased the yield significantly. This yield remained more or less constant upto 60 lb. N/A after which the yield declined. The yield obtained with plots given 80 lb. N/A was the same as the control plot.

In the previous years the yield obtained with application of ammonium sulphate alone increased upto 40 lb. N/A and the maximum yield in combination with compost was between 20 and 40 lb. N/A.

This year in the compost plots, the basal dressing alone has yielded the same as 20 lb. N in shape of ammonium sulphate, giving a significant increase over the control. With increasing doses of ammonium sulphate the compost plots have not recorded any further increase in yield and the depressing effect in yield starts earlier in this case than in the plots with ammonium sulphate alone.

(vi) *N, P, K Experiment.*—This is the 3rd year of the experiment and is being conducted, as has been previously reported, to determine the suitable combinations of the three major fertilizing elements, N, P, and K, and to find their relative performance with various organic manures as green manure (*Dhaincha*), compost and groundnut cake. The experiment was carried out, as in the previous years, with fertilizers at three levels of 0, 20 and 40 lb. of N, $P_2O_5$ and $K_2O$. The organic manures were applied to supply about 20 lb. N per acre. The experiment was carried out with the same layout and treatments as in the previous years.

As in the previous years no response was obtained with $P_2O_5$ and $K_5O$ nor there was any interaction. The yield data with application of ammonium sulphate are given below:—

*Yield in lb. per acre*

| Ammonium sulphate lb. N/A | No manure | Compost | Groundnut cake | Dhaincha | Mean | C.D. |
|---|---|---|---|---|---|---|
| 0 | 2304 | 2360 | 2486 | 2530 | 2420 | 155·2 |
| 20 | 2434 | 2494 | 2429 | 2404 | 2440 | |
| 40 | 2372 | 2534 | 2509 | 2552 | 2492 | |
| Mean | 2370 | 2463 | 2475 | 2495 | | |

It will be seen that 20 lb. N applied as ammonium sulphate or groundnut cake or green manure gave practically the same response, while there was hardly any response with compost on the same nitrogen basis. As in the previous years, the application of ammonium sulphate over groundnut cake or green manure applied at 20 lb. N per acre, did not increase the yield.

## D. Second Crop Experiments

*Mode of application of ammonium sulphate to the second crop of rice.*—The comparative efficiency of wet and dry application of ammonium sulphate to rice in the main season has been under study for the past 3 years, and the results have already been discussed. During the second crop season this year, wet and dry application of the fertilizer was tested in an experiment with variety Ch. 47 grown between December to April. In addition to the dry and wet application of the fertilizer as employed in the 1st crop experiment, the ammonium sulphate was

mixed with soil and made into pellets, which were applied deep in the soil to the standing crop. The ammonium sulphate was applied at two levels, *viz.*, 20 and 40 lb. N/A. For the wet application, the fertilizer was applied at one dose at planting, and also split, and applied at planting, two weeks after planting, and 2—3 weeks before flowering. While in the dry application the entire fertilizer was applied in one dose.

The results show that wet application of the fertilizer in one dose or split doses was inferior to the dry or deep application. Wet application at 40 lb. N/A gave more or less the same yield as 20 lb. N/A applied dry. Splitting the doses did not have any advantage over applying the entire fertilizer in one dose.

## E. Extension Trials

To confirm the results obtained at the Institute with regard to the dry and wet method of application of ammonium sulphate, 17 trials were conducted in five villages on cultivators holdings. The results are given below:—

*Mean yield of 17 plots in lb. per acre*

| | Mean yield | Percentage over control |
|---|---|---|
| No manure (Control) | 1803 | 100 |
| Wet application 20 lb. N/A | 2107 | 116·9 |
| Dry application 20 lb. N/A | 2267 | 125·8 |

The finding, that dry application is superior to wet application is confirmed from the trials conducted in the cultivators fields.

## Statistics

1. *Study of variation, correlation and selection in progeny row trials*

This investigation was carried out with the data obtained in progeny row trials with a variety ADT-20. There were 58 progenies grown in single row plots replicated six times. In addition to yield, data on total number of tillers, ear-bearing tillers and height at flowering were recorded.

(a) *Variation and distribution.*—It was found that the distribution of the progeny means for none of the above mentioned characters showed a significant departure from normality. The coefficient of variation (C.V.) was least for height, being only about 3 per cent, while for other characters, it ranged from 12 to 16 per cent. The heritability for all characters varied from 53 to 58 per cent.

(b) *Correlation.*—Among the characters, yield, number of ear-heads and plant height at flowering, the highest correlation was between yield and height, being about 0·638, while the correlation between yield

and tillers was 0·601. The genotypic correlations also showed more or less the same trend. The multiple correlation of yield on height and earhead number was 0·74.

(c) *Selection based on discriminant function.*—In selecting progenies it was found that a discriminant function based on yield, earhead numbers, plant height and flowering was not more efficient than straight selection based on yield alone. However, it was found that a discriminant, based only on earhead number and plant height at flowering, could be used satisfactorily for preliminary rejection of progenies. In discriminant formula, plant height had a weight of 3·8 compared with a weight of 1 for earhead number, indicating thereby the value of plant height as an index for selection in progeny row trials.

### II. *Sampling Studies*

During the season an experiment was conducted to study the relative efficiency of different types of sampling units, such as squares of different sizes, linear units, random plants and systematically taken plants for estimating yield and other plant attributes. The analysis of the data is not yet complete. Compilation of information on sampling in field experiments conducted at the Institute is also being carried out. It was found that with plot sizes ranging from 250 to 500 sq. ft. for estimating tillers per unit area, about 4 samples of $2' \times 2'$ per plot gave about 60 to 70% of the relative information. For height a very high accuracy, *i.e.*, of about 3% C.V. can be obtained even by taking only the 4 corner plants of a $2' \times 2'$ square, three to four such samples being taken from each plot.

### III. *Growth Studies*

Growth studies indicated that for very long duration varieties, the logistic or exponential curves do not fit adequately. The data upto flowering time and a quadratic function of time with a positive coefficient for the quadratic term gives better fit to the data upto flowering time. For the same period an exponential curve was found to give better fit for medium duration varieties.

## BOTANY

### 1. Maintenance and study of Genetic stocks including wild rices

The collection of genetic stocks maintained at this Institute was augmented by addition of 107 cultivated and wild types received during the year from various sources in India and abroad. Of the foreign types, one each was received from Ceylon and U.S.A., two from Philippines, three from Sierra Leone, seven from Indonesia and fifteen from Ecuador. The foreign additions included three wild species, *viz.*, *O.staphii, O.brachyantha* and *O.grandiglumis,* all from Sierra Leone.

The number of collections in genetic stocks is now 2568. Flowering duration of the entire collection was recorded and morphological and agronomic characters studied in some of them. 128 seed samples were supplied on request to foreign countries and to different States in India.

## II. Improving Rice Yields

(a) *Introduction.*—The yield performance of 72 promising types from the genetic stocks was studied during the year. Twenty-seven of these types were tested for the first time, and the rest were brought forward on the basis of their yield performance in the tests carried out last year. The types were grouped according to their duration and tested in the following six trials laid out in randomised replicated plots with six replications each:—

*1st year—*

(i) 151-160 days duration trial with T1242, T90 and BAM9 as controls.

(ii) 161-170 days duration trial with 18 types with $AKP_{11}$ and $Co_{14}$ as controls.

*2nd year—*

(iii) 151-160 days duration trial with 10 types with T1242 and T90 as controls.

(iv) 161-170 days duration trial with 6 types with Adt 10 and $AKP_{11}$ as controls.

*3rd year—*

(v) 141-150 days duration trial with 10 types with T812 and T1145 as controls.

(vi) 151-160 days duration trial with 15 types with T1242, T90 and GEB24 as controls.

Among the types tested for the first time in the 151-160 days trial none were found superior to the controls, T1242 and BAM9, while two types, *viz.*, T1560 and T1583 were significantly better in yield than the third control, *viz.*, T90. In the 161—170 days trial none of the types proved to be superior in yield to the control $AKP_{11}$ and only one type, *viz.*, T843 was found superior in yield to $CO_{14}$, the second control.

Among the types tested for the second successive year, while in the 151-160 days trials none were better in yield than the control T1242 one type, T409 was formed significantly higher in yield than the second control T90. In the 161-170 days trial the type T1591 out-yielded the control Adt 10 and none were better than the $AKP_{11}$ the second control.

Among the types tested for the third time, in the 141-150 days trial five types, *viz.*, T1850, T1240/4, T209, T2074, and T1844 were found significantly superior in yield to controls T1145 and T812. The increase in yield of these types over T1145 ranged between 15—27 per cent. The yield performance of these types compared to T1145 during the past 3 years is given below. These types along with T1285, which has also performed well in the last 3 years, will now be put under large scale tests. It may be mentioned here that T1850, which is a type from Berhampore (Orissa), is non-lodging in habit.

| Types | 1949-50 | | 1950-51 | | 1951-52 | | Mean | |
|---|---|---|---|---|---|---|---|---|
| | Yield lb./ acre | Percentage on T1145 | Yield lb./ acre | Percentage on T1145 | Yield lb./ acre | Percentage on T1145 | Yield lb./ acre | Percentage on T1145 |
| T1850 | 2516 | 127·6 | 2543 | 120·2 | 3094 | 134·5 | 2718 | 127·5 |
| T1240/4 | 2636 | 133·1 | 2548 | 120·4 | 2776 | 120·7 | 2653 | 124·4 |
| T209 | 2874 | 145·1 | 2848* | 96·0 | 2613 | 113·6 | 2778* | 115·0* |
| T2074 | .. | .. | 2557 | 120·8 | 2602 | 113·1 | 2579 | 120·9 |
| T1844 | 2665 | 134·6 | 3359* | 113·2 | 2557 | 111·6 | 2860* | 118·3* |
| T1285 | 2606 | 131·6 | 2398 | 114·3 | 2441 | 106·1 | 2482 | 116·4 |
| T1145 | 1980 | 100·0 | 2116 and 2967* | 100·0 | 2301 | 100·0 | 2132 and 2416* | 100·0 and 100·0* |
| C.D. | 380 | | 441 and 486* | | 136 | | | |

In the 151-160 days duration 3rd year trial, while none of the types were found superior to the control T1242, two of the types, *viz.*, T1286 and T587 were significantly superior in yield to the control T90.

(b) *Selection.*—As has been reported previously, investigation is in progress to study the genetic variability and to determine the value and scope of secondary selection in rice breeding. This year the study consisted of (a) trial of secondary selections from T1222-12 material, (b) small bulk trial with the material from T1222-12, (c) trial of primary selections made last year in Adt 4 and Adt 20, two short duration improved strains of Madras State, (d) trial of secondary selections made in *Chinamali* and *Kankisal* two commercial varieties of Orissa, and (e) trial of first selections made in BAM-9, an improved strain of Orissa State.

*Trial of* T1222-12 *secondary selections.*—As was reported last year, significant differences in yield were found to be present even after 3 years of continuous selection in families 116-30 and 116-88 of the T1222-12 material. Further selections made in these families were, therefore, carried forward and tested in a compact family layout, consisting of 7 families with 6 progenies in each, along with T1222-12 original bulk in 6 replications.

The results showed significant differences in yield between families and all the families were found to be superior in yield than the T1222-12 original bulk. Further in all the families significant differences in

N.B.– *Two trials were with T1145 as control conducted in 1950-51. The two types marked with asterisk, *viz.*, T209 and T1844 were in one and the remaining types in the second trial.

In 1949-50 type T2074 was not tested against T1145.

yield were found between the progenies, thus showing variability even 4 years after the original selections were made. The performance in 1951-52 of the T1222-12 bulk and of the progressive selections made is given below:—

| | Mean yield per plot (oz.) | Percentage on T1222-12 (bulk) |
|---|---|---|
| T1222-12 (bulk) | 10·94 | 100·0 |
| T1222-12-116 | 14·37 | 131·4 |
| T1222-12-116-30 | 14·67 | 134·1 |
| T1222-12-30-58 | 15·16 | 138·6 |
| T1222-12-116-30-106 | 15·32 | 140·0 |
| T1222-12-116-88 | 13·99 | 127·9 |
| T1222-12-116-88-62 | 15·23 | 139·2 |

*Small bulk trial of* T1222-12 *material.*—As has been previously reported superior and inferior family bulks, made up by bulking two best and two worst progenies in each family, were tested in 1950-51. The superior families on an average yielded 13 per cent better than the inferior group and there were no significant differences in yield within the superior and inferior groups. The performance of the superior and inferior families was again tested this year in a randomised replicated plot layout with 6 replications. The results confirm the findings of the previous year. The superior bulks were on an average 7·7 per cent better than the inferior group.

*Trial of Adt* 4 *and Adt* 20 *primary selections.*—Seventy-one and sixty-six of the first selections made last year in Adt 4 and Adt 20 respectively, were tested during the year in replicated progeny row trials with 6 replications. Significant variations in yield were found between the progenies, showing that significant genetic variability was still present in both the varieties. Selections made in 15 of the best progenies in each variety are being carried forward for further work.

Chinamali *and* Kankisal *selections.*—Selections made last year in *Chinamali* and *Kankisal* were tested in two compact family layouts during the year. In *Chinamali* trial, 18 families each with 6 progenies were tested. Significant differences in yield were found between families, 7 of them being significantly superior to *Chinamali* bulk. In the within family comparison significant differences in yield between the progenies were found in five families. Further selections made in these five families are being carried forward.

In *Kankisal* trial, 19 families each with 6 progenies were tested. Significant differences in yield were found between families, 15 of the families proved significantly superior to *Kankisal* bulk. In the within

family comparison significant differences in yield between the progenies were found in two families.

*Selections in BAM9.*—250 random primary selections were made in BAM9 to study genetic variability and find out if there was scope for further selection in this Orissa strain.

*Trial of* Jhelli *and* Kavinginpoothala *selections.*—Six promising cultures of *Jhelli,* a commercial variety of Orissa, brought forward from last year, were tested against T90. Culture No. 175 which out-yielded T90 by 20 per cent last year, maintained its superiority, yielding 15·4 per cent more than T90 this year. In another trial two selections for variety *Kavinginpoothala* were found to be superior to the parental material, giving an increase in yield of 31 to 57 per cent. These cultures are suitable for growing in low lying areas.

## III. Hybridization

(a) *Hybridization between* indica *and* japonica *groups.*—Two projects of intensive hybridization between the *japonica* and *indica* races of rice, one sponsored by the F.A.O. and the other by the I.C.A.R. are in progress at this Institute. The object of these two projects, as has been previously reported, is to combine the high yield and good response to manuring of the *Japonica* rices with the hardiness and adaptation to tropical conditions characteristic of the *indica* rices. The programme is being carried out in two stages: (i) crossing the *indica* varieties selected by the several participating countries to the *japonicas* obtained from Japan, growing and studying the $F_1$ generation at Cuttack and making available to the participant countries seeds for the $F_2$ generation; (ii) making selections in the material supplied from Cuttack by the respective countries themselves according to their requirements.

In the F.A.O. project, as has been previously reported, 9 South and South East Asian countries besides India, are participants; under this scheme 33 *indica* varieties of these countries are being crossed to 8 *japonicas.* During the year 1,29,421 cross pollinations were done and 15,603 crossed seeds collected. Out of the 270 cross combinations to be made under the scheme 160 have now been completed. $F_1$ generation from the 92 cross combinations made during 1950-51 involving a population of 3000 plants was grown and studied for height, number of ear-bearing tillers, duration, sterility and other characters. The hybrids were vigorous in growth and intermediate between the two parents in flowering duration and good in tillering. It may be mentioned here that varying degrees of spikelet sterility, ranging from 15 to 95 per cent. was observed in the hybrids from various cross combinations. Seed from $F_1$ generation for growing $F_2$ generation of these cross combinations were sent to seven Asian Countries, *viz.,* Burma, Ceylon, Indo-China, Indonesia, Malaya, Philippines and Thailand and to Orissa and Madras States in India.

In the I.C.A.R. Scheme 16 Indian States are participating and 32 *indica* varieties are being crossed to 6 *japonicas.* During the year 70,916 crosses were made and 11,783 seeds obtained, out of the 192 cross combinations contemplated under the scheme, 112 combinations were completed.

Experience of crossing throughout the year has shown that under Cuttack conditions the optimum season for setting is September to November. The percentage setting to pollinations, which is lowest in January, rises sharply till March, remains more or less steady till July and reaches its maximum between September and November after which it falls off suddenly.

(b) *Within* indica *group.*—As has been previously reported this project has been undertaken to breed early maturing and high yielding strains by hybridization within the *indica* group. During the year $F_2$ generation involving the following 10 cross combinations was grown: --

(1) T1145 × *Sathika*
(2) T1145 × China 2
(3) T1145 × T1031
(4) T812 × *Sathika*
(5) T812 × T1031
(6) T1242 × *Sathika*
(7) T1242 × T1031
(8) T90 × *Sathika*
(9) T90 × T1031
(10) BAM9 × *Sathika*

The plants were studied for flowering duration, number of ear-bearing tillers and rice colour in the field, and 1514 field selections were made on the basis of early flowering, good tillering and white rice. The selections were further studied for yield and 242 selections were finally retained for further work. The majority of selections so obtained are from the crosses between T1031 (early Chinese variety) and T1242 and T1145 (high yielding Orissa varieties) and between *Sathika* (early maturing local variety) and T1145.

## IV. Genetics of Pigmentation, Grain Size and Other Characters

*Pigmentation.*—$F_1$, $F_2$ and $F_3$ generations of several crosses in this investigation were grown, a detailed analysis of the data is, however, in progress. Leaf blade in rice may be green, purple wash or dark purple. In crosses between green leaf blade and purple wash, the $F_2$ segregated into 9 purple wash : 7 green. In crosses between green leaf blade and dark purple, the $F_2$ segregated into 55 green : 9 dark purple, and in crosses between purple wash and dark purple three phenotypes were obtained in the $F_2$ in the ratio of 36 purple wash : 12 dark purple : 16 green. It would appear from the data that 3-4 genes are concerned in the production of pigmentation in the leaf blade, the role and inter-relationship of these genes are being examined.

A close linkage has been established between glume colour and apiculus colour with a crossing over value of 1·2 per cent.

Considerable variation occurs in pericarp colour and inheritance of this character has been investigated by a number of workers. None, however, appear to have reported the segregation of purple—brown—white in crosses between purple and white rice and this has been recorded at this Institute. Production of red as well as purple pericarp has been reported as dependent on factor A by previous workers; in its absence $P_{rp}$ produces brown rices. The cross studied here was therefore, between purple rice with AAPpP$_{rp}$ constitution and white rice with aaprpprp, thus giving $9P_{rp}\,A$ (purple): $3P_{rpa}$ (brown) : $4_{prp}\,A$ plus prpa (white).

*Auricle.*—A rare variation in auricle was observed in the collection of genetic stocks available at this Institute. The auricle was found to be rudimentary, greatly reduced in size, being just a protuberance without cilia or having 1--2 cilia at the most. This rudimentary auricle was found to be a simple recessive to the normal auricle usually found in the rice plants.

*Notched kernel.*—The rice kernel shows considerable variation in shape, size, colour, endosperm character, scent, etc. An unusual variation, which has not been reported before, is in the outline of the kernel. Instead of the usual unbroken periphery of the kernel, the variation consists of a notch in the kernel on both sides. This condition of the kernel has been named "notched kernel".

The notched kernel was crossed to the common unnotched kernel, the $F_2$ segregated into 13 unnotched : 3 notched kernels. The notched-unnotched condition of the kernel is governed by a single factor pair and an inhibitor gene affects the expression of the notched character. The notched-unnotched factor pair has been designated NK—nk.

This cross was also studied for pericarp colour and scent. The notched kernel was found to be independent of the genes governing pericarp colour and scent character in this cross as shown below:—

*Notched kernel and pericarp colour*

| | Unnotched | | | Notched | | | Total |
|---|---|---|---|---|---|---|---|
| | Purple | Brown | White | Purple | Brown | White | |
| Observed | 180 | 63 | 106 | 54 | 14 | 19 | 436 |
| Expt. (117 : 39 : 52 : 27 : 9 : 12. | 199·3 | 66·5 | 88·6 | 45·9 | 15·5 | 20·4 | 436 |
| | $\chi^2$ =7·099 | | | P=0·30-0·20 | | | |

*Notched Kernel and scent*

| | Unnotched | | Notched | | Total |
|---|---|---|---|---|---|
| | Non-scented | Scented | Non-scented | Scented | |
| Observed | 266 | 83 | 67 | 20 | 436 |
| Expt. (39 : 13 : 9 : 3) | 265·7 | 88·6 | 61·3 | 20·4 | 436 |

*Scent.*—This character has been worked on by several investigators, reporting monogenic, digenic and trigenic inheritance. However, all the previous workers have reported that non-scent was recessive to scent. In the cross studied here, non-scented character was found dominant

over scent, the $F_2$ generation segregating into 3 non-scented : 1 scented. The scoring was done by chewing the rice and the observations were frequently confirmed by boiling the grain in water.

*Pistil abnormality.*—The multi-pistillate condition in rice is a simple recessive to the normal simple pistil condition. In the multi-pistil types, *viz.*, T787 and T783 in the collection of genetic stocks at this Institute, it was found that most of the spikelets in these types had a peculiar shaped hyaline, fleshy structure arising from the ovary. This structure was of varying shape and size. Usually in a spikelet only one pistil had a prominent fleshy structure, alongside the normal two styles, while in the other pistils the fleshy structure was small and inconspicuous. Occasionally, however, in a pistil all the three styles were normal with no fleshy structure present. In crosses with single pistil types the fleshy structures were found to be inherited along with the multiple pistil as a simple recessive.

*Grain Size.*—Necessary crosses were made to get simultaneously in one layout $F_1$, $F_2$ and $F_3$ generations along with parents for next years work. 50 $F_2$ plants were carried forward for the $F_3$ generation, the necessary data on all the generation along with the parents will be recorded next year.

## V. Physiology

*Photoperiod response of rice.*—Information has been collected on the response of rice varieties to photoperiod in connection with the *indica* × *japonica* rice hybridization project. With regard to time and duration of short day treatment it has been found that 8 hours short day treatment in the first half of the day given to 30 days old seedlings for 20 days gave the best response under Cuttack conditions. The data are summarised below :—

*Photoperiod treatments*

| | Control plants | Photoperiod given during | | Photoperiod daily duration | | No of days photoperiod given | | |
|---|---|---|---|---|---|---|---|---|
| | | Fore-noon | After-noon | 8 hrs. | 10 hrs. | 20 days | 30 days | 40 days |
| Mean flowering duration in days. | 116·6 | 84·4 | 94·8 | 91·0 | 88·1 | 90·8 | 88·8 | 39·1 |

Observations on response to photoperiod of 33 Indian varieties of varying duration shows that the response increased from the early duration to the longer duration varieties. These varieties were given in May, short day treatment of 8 hrs. daily, during the first half of the day for 20 days, starting when the seedlings were 30 days old. The results are summarised below :—

| Control Flowering duration | Mean response to photoperiod |
|---|---|
| 71–80 days | 11·5 days |
| 81–90 days | 19·0 days |
| 91–100 days | 30·4 days |
| 101–110 days | 35·5 days |
| 111–120 days | 46·4 days |
| 121–130 days | 52·7 days |

Photoperiod response of 25 *indicas* of varying duration, from 8 different South Asian countries, treated to short days during different periods of the year, is on the lines indicated for the Indian types. In all the varieties tried, in no case the photoperiod treated plants came to flower earlier than 58-59 days from sowing.

## CHEMISTRY

### A. Laboratory investigation

Laboratory facilities in the form of gas, electric and water supplies were available towards the end of the year. Mechanical analysis and soil reaction studies of a number of soil samples collected from different locations in the Institute farm was undertaken. The soil on the farm can be texturally characterised as (i) sandy clay loams (uplands), (ii) clay loams (medium lands), and (iii) clay (low lands). The soils are slightly acidic in nature, the pH varying from 6·0 to 6·8 units.

### B. Field Investigations

I. *Seed soaking in nutrient solution.*—Investigations conducted during the past 3 years on treatment of seeds before sowing in solution of nutrients, in which the soil was deficient, gave some promising results. Treatment in solution of $K_2HPO_4$ has consistently given yield increase over the control for the last 2 years. Work this year was carried out on three varieties of rice, *viz.*, Co. 13 (early duration), T1145 and T141 (medium duration). Nutrient solutions employed were $K_2HPO_4$ and $K_3PO_4$ at 10 and 20 per cent concentrations, and concentrated solution of ammonium sulphate (1 : 2 in water) with addition of little amount of starch to make the fertilizer adhere to the grain after drying. Treatment affected the germination of seed and seed rate was accordingly adjusted to maintain uniform stand. The treatments were sown in plots with and without a basal dressing of ammonium sulphate to supply 20 lb. of nitrogen per acre. The data are given below:—

*Yield of grain lb./acre*

| Treatments | Co. 13 | T1145 | T141 | Mean |
|---|---|---|---|---|
| 10% $K_2HPO_4$ | 1332 | 2259 | 2399 | 1997* (109·6) |
| 20% $K_2HPO_4$ | 1291 | 2300 | 2414 | 2002* (109·9) |
| 10% $K_3PO_4$ | 1215 | 2103 | 2338 | 1885 (103·5) |
| 20% $K_3PO_4$ | 1207 | 2240 | 2380 | 1942 (106·6) |
| Ammonium sulphate 1 : 2 in water 24 hrs. soaking | 1287 | 2240 | 2312 | 1946* (106·8) |

*Yield of grain lb. 1 acre*—contd.

| Treatments | Co.13 | T1145 | T141 | Mean |
|---|---|---|---|---|
| Ammonium sulphate 1 : 2 in water 6 hrs. soaking | 1257 | 2251 | 2376 | 1961* (107·6) |
| Water soaked | 717 (poor germination) | 2050 | 2319 | 1095 (93·0) |
| Control | 1219 | 2111 | 2137 | 1822 (100·0) |
| Mean | 1190 | 2194 | 2334 | |

* Values significant at 5% level.

C. D. for comparing treatment means (average of all varieties) = 121 lb.

C. D. for comparing treatment means within a variety = 207 lb.

NOTE.—The figures in brackets are percentage over control.

The result confirm the findings of the previous years. Chemical $K_2HPO_4$ both at 10 and 20 per cent concentration, has given significant yield increase of 9·6% and 9·9% respectively over the control. Treatment with concentrated solution of ammonium sulphate, which amounts to covering the seed with a thin coat of the fertilizer, has also given significant yield increase of about 7 per cent over the control. The interaction between chemicals and varieties and between chemicals and nitrogen treatment as well as the triple interaction (chemicals × varieties × nitrogen) were not significant.

Trials with seed of T1145, soaked in 20% solution of $K_2HPO_4$, for 24 hours prior to sowing were also conducted on a large scale field experiment at the Institute and in cultivators fields in the intensive cultivation centre.

In the experiment at the Institute farm, an increase in yield of 3·5 per cent. over the control was obtained. In the cultivators lands, where the experiment was laid out in nine fields selected at random in the four different villages, an average incerase in yield of 8·7% over the control was obtained.

The effect of seed soaking in nutrient solution was also tested for transplanted crop with variety T1145 treated with 20 per cent solution of $K_2HPO_4$ and concentrated solution of ammonium sulphate (1 : 2 in water). Results showed a significant increase in yield of 7·8% over the control with ammonium sulphate, while $K_2HPO_4$ gave an increase of only 3·8% over the control.

II. *Phosphate manuring.*—As in the previous years phosphate fertilizing upto 60 lb. $P_2O_5$ per acre as super-phosphate, either applied alone or in combination with ammonium sulphate and lime, did not give response. Higher doses of super-phosphate upto 120 lb. $P_2O_5$ per acre were therefore tried, alone and in combination with ammonium sulphate, in both the main and second crop seasons. The super-phosphate was either applied broadcast on the surface or as pellets placed deep in the soil. No increase in yield was obtained even with the increased doses of the fertilizer.

In pot experiments laid out *in situ* in the field, where super-phosphate upto 60 lb. $P_2O_5$ per acre has been applied for the last two years, there are indications of increase in yield in pots receiving 60 lb. $P_2O_5$ per acre, but the increase is not significant.

III. *Deep placement of Ammonium Sulphate fertilizers.*—Work in the previous years with the placement of sulphate of ammonia 2″-3″ deep in the sub-surface zone of the soil in the form of pellets after planting, showed that the efficiency of the fertilizer was considerably more than when applied by the customary broadcast method of application on the surface of the soil. The deep placement of fertilizer was further tested both in the *kharif* and *dalua* season and the results obtained confirm the previous findings. The data are presented below:—

*Yield of grain lb./acre*

| Nitrogen levels per acre | Variety T90 Main season (Kharif), June—December | | Variety Ch. 47 Second season (Dalua) December—April | |
|---|---|---|---|---|
| | Surface application | Deep placement | Surface application | Deep placement |
| No Nitrogen . . | 2541 (100·0) | .. | 1222 (100·0) | .. |
| 20 lb. N . . | 2676 (105·3) | 2768 (108·9) | 1290 (105·5) | 1500 (122·6) |
| 40 lb. N . . . | .. | .. | 1589 (130·2) | 1565 (128·0) |
| | C. D.=100 lb. | | C. D.=220 lb. | |

Efficiency of deep placement over surface application for 20 lb. N level.

Main season crop=227/135=1·68.

Second season crop=278/68=4·09.

NOTE :— Figures in brackets are percentages on control.

Deep placement of fertilizer was also tested out in cultivators fields. The experiment was laid out in seven fields selected at random in two different villages. Surface application and deep application of the fertilizer was done at 20 lb. N per acre one month after transplanting. The fields had received a customary dose of farm yard manure and were also lightly green manured before transplanting. Deep placement on an average significantly increased the yields by 8·1%, while surface application gave only an increase of 1·2 per cent over control yield of 2458 lb. per acre.

IV. *Minor Elements for Rice Culture.*—Work in the previous years indicated increase in yield of transplanted rice by application of varying doses of borax. This year the trace element, in the form of borax at 20 lb. and 40 lb. per acre and copper in the form of copper sulphate at 10 lb. and 20 lb. per acre, were tested on variety Co. 13

grown in upland field of low fertility. The trace elements were applied to the soil before sowing and the treatments tried with and without ammonium sulphate at 20 lb. N per acre. The data are given below:—

*Yield of grain lb./acre*

| Treatment | N-0 | N-20 | Mean |
|---|---|---|---|
| Control | 494 | 846 | 670 (100·0) |
| Borax 20 lb./acre | 490 | 979 | 735 (109·7) |
| Borax 40 lb./acre | 626 | 1078 | 852 (127·2) |
| Copper sulphate 10 lb./acre | 706 | 1063 | 885 (132·1) |
| Copper sulphate 20 lb./acre | 569 | 1253 | 911 (136·0). |
| Mean | 577 | 1044 | |

C. D. for comparing treatment means (average of nitrogen and no nitrogen plots)=196 lb

C. D. for comparing treatment means within a nitrogen treatment=278 lb.

Note.— Figures in brackets are percentages over control.

Significant increase in yield of 32 and 36 per cent over the control were obtained with 10 and 20 lb. of copper sulphate respectively per acre. 40 lb. borax treatment gave an increase in yield of 27% which however, was not significant. The interaction between nitrogen treatments and minor elements was not significant, but it was noticed that there was a trend that with nitrogen application a high level of the trace elements, borax or copper was needed to increase yield.

Experiments with trace elements were also conducted during the second crop season with variety Ch. 47 grown on a medium land. No yield increase with the application of either of the two trace elements were recorded.

## ENTOMOLOGY

### A. Field Pests

I. *Varietal susceptibility to gall fly (Pachydiplosis Oryzae).*—Work done in the previous years showed that, in general pigmented varieties and scented varieties were less affected by gall fly and at the same time it was also noted that such varieties were poor in tillering. The experiment this year was therefore designed to investigate whether it was the pigment or the scent which repelled the insects, and greater number of scented varieties and green varieties with poor tillering were taken. The experiment included 20 varieties, consisting of 7 green non-scented, 8 green scented and 5 purple non-scented types. The recording of gall fly incidence was done on the lines adopted in the previous years. The green non-scented varieties in general were found to be more susceptible than the green scented and purple varieties as shown below :—

(i) Percentage of gall fly ranged between 61·4 to 36·4 among the green non-scented varieties.

(ii) Percentage of incidence of gall fly attack in green scented varieties ranged between 46·7 to 9·4.

(iii) Percentage of gall fly attack in purple varieties ranged between 48·9 to 5·3.

Further, it was found that among the green non-scented varieties, the gall fly incidence was less in varieties with lower tillering habit than those with higher tillering habit.

It was also observed that gall fly attack induced tillering. Whether this increased tillering, induced in the susceptible varieties, could compensate for the loss in yield needs investigation.

II. (a) *Date of planting and its relation to incidence of gall fly.*—As has been reported this experiment is in progress to determine the relative incidence of gall fly at different stages of the growth in the plant and to find out the season in which the insects are more abundant than at other times. As in the previous years the investigation was carried out with 2 varieties, *viz.*, Ch.45 and DI.4. Planting was done at fortnightly intervals and the plants examined when 30 and 60 days old. The data showed that gall fly incidence was more in 60 days old seedlings than in 30 days old seedlings irrespective of the time of planting. This is in conformity with the previous findings. The peak period of incidence this year was found to be from middle of October to middle of November, while the peak period in the previous years was found to be from end of October to end of November.

(b) *Seedling treatment against gall fly.*—In the previous experiments, as has been reported, treatment with DDT was found ineffective against gall fly incidence. This year in a preliminary experiment with spraying the seed bed with 0·1% BHC and dipping the seedlings in a water suspension of the same insecticide before transplanting followed by 3 sprayings of the transplanted crop, it was found that gall fly incidence could be reduced to some extent. This finding needs further investigation.

(c) *Use of indigenous plant product as insecticide.*—In a preliminary experiment, distillate of powdered rhizome of *Acorus calamus* was found to have good insecticidal properties. Investigations on control of gall fly with this distillate are being undertaken.

III. *Studies on stem borers incidence.*—(a) *Control method of stem borers.*—As has been previously reported considerable loss is caused to the summer or *dalua* crop by stem borers, *Schoenobius incertellus*, being the borer mainly responsible for this damage. As the borer was an internal feeder, chemical control was not effective after the larva had bored into the stem.

Work done last year showed that dipping the seedling in 0·1% BHC had no deleterious effect on the plants and the time of spraying should coincide with brood emergence.

Further work carried out with seedlings dipped in BHC, grown in enclosed wire cages and sprayed with BHC showed that:—

(i) All moths introduced in the cages died the next day, while in the control cage without treatment, some moths survived.

(ii) No egg masses were laid on treated plants, while many egg masses were laid on the control plants.

(iii) The residual effect of the insecticides lasted for 5—7 days on the sprayed plants, and in the dipped plants for 3 –5 days.

(iv) BHC spraying had no effect on the egg masses.

Study of the brood emergence with light traps showed that *Schoenobius* had 5 broods per year commencing from the middle of September.

With the above information on the behaviour of stem borer, control measures were tried in a field experiment in the *dalua* season with variety D14, which is highly susceptible to stem borer. The dipping and spraying was done in 0·2% BHC. The treatments were as given below :—

| *Pre-transplanting* | *Post-transplanting* |
|---|---|
| (i) Control. | (i) Control. |
| (ii) Dipping. | (ii) Early spraying (to control broods attacking the young transplanted seedlings). |
| (iii) Nursery spraying. | (iii) Late spraying (to control brood emergence at shotblade stage). |
| (iv) Nursery spraying plus dipping. | (iv) Early and late spraying. |
| | (v) Regular spraying at interval of 4 days. |

The borer incidence was studied in samples taken 30 and 60 days after transplanting. The results of the experiment indicate that:—

(i) Nursery spraying followed by dipping of seedlings before transplanting and regular periodical spraying resulted in less number of attacked tillers.

(ii) Early spraying also showed diminished attack but the difference was not significant compared with unsprayed treatment.

(iii) Regular spraying resulted in decreased incidence of white earheads and yield obtained was significantly higher compared to yield from the control and other treatments. The increased yield was 32 per cent higher than from the control plots. The higher yield was found to be due to the greater number of ear-bearing tillers than in the other treatments.

(iv) The total number of tillers in all the treatments, including the control, was found to be more than in the treatment with regular periodical sprayings. These increased tillers were, however, only vegetative tillers or tillers just about to flower. It may be concluded that borer attack induced subsidiary tillering which did not develop to produce grain.

(v) The effect of late spraying was not very significant in this experiment. This may be due to the fact that brood emergence lasted for more than 15 days while the spraying was done for only part of the period of brood emergence.

(b) *Intensity of borer incidence within a field.*—A plot of GEB24 was divided into 8 concentric regions. Examination of white earheads in samples drawn from all regions showed that the intensity of borer incidence was more towards the centre than the periphery of the plot.

### B. Pests of Stored Grain

(i) *Origin of infestation in stored paddy.*—Work in the previous years had shown that initial infestation by the grain moth, *Sitotroga cereallela* and rice weevil *Sitophilus oryza* starts on the grains of the standing crops. Work carried out on 8 varieties this year to determine the stage of the grain at which the insects attack the standing crop, showed that though there were instances of insect attack at the milk and dough stages, the ripe grain was generally attacked.

(ii) *Store pests attacking differently processed rice.*—Work on this investigation this year was carried out on variety T1242 from April to November. As in last year, the differently processed rices were raw and parboiled with either unpolished or rices with different degrees of polishing. The insect pests observed in rice were *Rhizopertha dominica* and *Tribolium castaneum* and the larvae of *Tebenroides mauritanicus* and *Tribolium castaneum* were predominant. As with the investigation with T90 last year, this year also it was found that the total number of insects and damage was significantly more in raw rice than in parboiled rice and the differences within the degrees of polishing were not significant.

(iii) *Insecticidal trials to control store pests in paddy.*—With the object of finding out indigenous insecticides which were harmless for handling and which would be effective in controlling the storage pests, the efficiency of powdered rhizome of *Acorus calamus* (sweet flag) was compared with three chemical insecticides, *viz.*, Hexapure, Gammexane D.024 and Geigy 33. The chemical insecticides were dusted on the bags at the recommended dose of 1 lb. per 100 sq. ft., while the powder of *Acorus calamus* was fixed with the grain at the rate of 2 lb. per 100 lb. of grain. Insect pests observed during the course of the experiment were *Rhizopertha dominica, Sitophilus oryza* and *Tribolium castaneum, Rhizopertha dominica* being predominant. Results obtained show that the insect population and damage in the bags treated with *Acorus calamus* were significantly less than the other treatments.

## MYCOLOGY

### I. Helminthosporium Disease

(a) *Varietal susceptibility.*—Work on the determination of the susceptibility at the seedling stage of the Indian and foreign improved strains to *Helminthosporium* disease by artificial inoculation tests was continued.

During the 4 years the work has been in progress, 435 of 538 of the improved strains available at the Institute have been examined, and 83 of these have been found resistant in at least three (in some cases in all the four) infection tests carried out.

Besides the inoculation test, reaction of these varieties to the disease, both in the seedling and adult stage, had been studied under natural conditions of infections in the field.

Out of the 83 varieties found resistant in the artificial inoculation tests, the following 20 were found resistant, both in the seedling and adult stages, under conditions of natural infection.

1. Kaliboro
2. Ch. 13
3. Ch. 31
4. PtB 4
5. PtB 18
6. PtB 21
7. CP 16
8. Co. 10
9. Co. 23
10. T498-2-A
11. BAM. 10
12. Co. 6
*13. PTB 10
*14. PTB 12
*15. MTU. 12
*16. Co. 20
*17. Ch. 43
*18. Ch. 45
*19. Bom. 17
*20. T. 141

Further it may be mentioned that 8 of these varieties (marked with asterisks in the list) were also found resistant in an adult stage infection test. The resistance to the disease of these 20 varieties will again be tested in final inoculation tests, in the coming season.

(b) *Study of collateral hosts.*—As has been previously reported, search for collateral hosts of *H. oryzae* is in progress. The morphology of two isolates obtained from grasses was studied during this year. These isolates failed to produce spores in culture, but in gross morphology of the thalus they resembled *Helminthosporium oryzae.* During the year two more isolates from two other grasses were also obtained. All the four isolates will be studied for their morphology and pathogenecity during the next season.

(c) *Areoscope Studies.*—As in last year, greased slides exposed at weekly intervals in areoscopes, were examined 24 hours after exposure. the examination and count of the number of conidia in these slides showed that (i) conidia were present throughout the year, though in the off-season (April—June) their number was greatly reduced, (ii) the spores trapped in the colder months were relatively greater in number. and (iii) the weekly variation in the number of conidia trapped in any month was associated with the variation in the relative humidity and the amount of clouds.

(d) *Effect of cultural extracts of H. oryzae on the susceptibility of rice varieties.*—Results obtained previously showed that susceptibility of rice varieties to *Helminthosporium* was reduced by soaking germinating seeds in cold water extracts of *H. oryzae.* This was sought to be confirmed by field tests this year with treated seed of 4 susceptible varieties and 3 varieties showing certain degree of resistance to the disease. As there was very little disease in the field during the season no conclusive results could be obtained.

## II. Blast Disease of Rice

(a) *Varietal susceptibility.*—The tests carried out during the year on this aspect were unsuccessful.

(b) *Age of plants and incidence of Blast.*—Under Cuttack conditions the incidence of blast disease was comparatively more during

September and October. Previous work done with a moderately susceptible variety (T1145) had shown that during this period (September-October), the younger the plant, the greater was intensity of infection. So with the object of finding the relation between age of the host and its susceptibility, a field trial with a very susceptible variety, *viz.*, Co. 13 was carried out during the year under report. Month old seedlings of Co. 13 were planted on 4 different dates in 12 replications, half of the replications were fertilized with ammonium sulphate at 20 lb. N per acre.

Blast was noted in the late sown seed beds in the last week of July. In the transplanted plots the disease developed with moderate intensity during the September—October period. Observations were recorded as shown below:—

(i) Incidence of foliar infection on random samples of plants, 26, 36, 46 and 56 days old were recorded on 14-9-51,

(ii) A few days after flowering, the incidence of neck infection was recorded on random samples taken from the plots,

(iii) At harvest, plot yield and chaffy grains in the plots were recorded.

The data showed that intensity of foliar and neck infection was highest among the younger plants and the yield lowest in such plots. Further it was noted that the intensity of infection was generally higher in the manured series than in the unmanured series. The data are given in the table below:—

*Intensity of foliar and neck infection % of chaffy grain and mean yield per plots*

| | | Date of planting | | | | | |
|---|---|---|---|---|---|---|---|
| | | 19-7-51 | 28-7-51 | 8-8-51 | 18-8-51 | S.E. | C.D. |
| Manured Series | Foliar infection values on 14-9-51 . . | 2·45 | 3·77 | 4·78 | 4·81 | 0·33 | 1·00 |
| | % neck infection at flowering . . | 17·94 | 49·76 | 59·05 | 64·56 | 3·76 | 11·36 |
| | % chaffy grains . | 17·27 | 23·68 | 32·33 | 32·39 | 2·16 | 6·52 |
| | Mean yield per plot (oz.) . . . | 66·75 | 55·04 | 36·37 | 26·62 | 5·13 | 15·46 |
| Unmanured Series . | Foliar infection values on 14-9-51 . . | 1·32 | 2·78 | 4·11 | 3·53 | 0·26 | 0·79 |
| | % neck infection at flowering . . | 3·38 | 11·51 | 19·61 | 30·06 | 2·85 | 8·61 |
| | % chaffy grains . | 13·04 | 15·31 | 22·25 | 18·64 | 1·34 | 4·03 |
| | Mean yield per plot (oz.) . . | 83·75 | 74·41 | 57·41 | 45·75 | 2·57 | 7·74 |

The results obtained show that when a very susceptible variety, like Co. 13, has to be cultivated in a locality the loss likely to be caused by blast can be minimised by suitably adjusting the planting data with reference to the peak period of the incidence of the disease. Under Cuttack conditions this could be done by advancing the date of planting of Co.13 to the first week of July.

(c) *Loss caused by blast : Estimation and control by direct fungicidal spraying.*—During the last season it was found that loss caused by severe blast incidence could be minimised by fungicidal spraying. This finding was employed during the year under report to estimate the loss caused by blast in a field experiment with variety Co.13 planted towards the end of August with basal dressing of 20 lb. N per acre. Between planting and harvest spraying with Bordeaux 5 : 5 : 50, Bordeaux 2·5 : 2·5 : 50 and Perenox at the rate of 4 oz in 2 gallons was done four times. The first two sprayings 75 gallons of spray fluid and in the last two sprayings 100 gallons were used.

The incidence of the disease was estimated from the amount of neck infection present in the random samples taken from the various treated plots. For this purpose from each plot 2 random samples each 2 feet square were taken. The yield of the samples as well the plot yield were also recorded. Correlations were established between (1) the sample neck infection and yield of the sample, and (2) between the plot yield and the estimated plot infection.

The data shows that for every one per cent increase of neck infection there was a decrease of 0·72% in the yield from samples and 0·83% decrease in yield of the plots. Under the condition of the experiment the loss amounted to 7·37 lb. per acre in sample yield and 13·5 lb. per acre per plot yields for every increase by 1% of neck infection. The lower value obtained with samples is due to the sample yields being more variable than plot yields and hence correlation with plot yields would be a more accurate estimation of the loss caused by the disease.

(d) *Effect of fungicides on control of blast.*—The effect of fungicides on control of blast may be seen from the table given below. Spraying with Bordeaux of 5 : 5 : 50 strength four times in the crop season reduced the percentage of neck infection to half of the infection present in the control plots (36%). This reduction in neck infection increased the yield by 55% over the control yield. The data are given below :—

*Effect of spraying on 'neck infection' and yield on Co. 13*

| | Bordeaux mixture 5 : 5 : 50 | Bordeaux mixture 2·5 : 2·5 : 50 | Perenox | Control |
|---|---|---|---|---|
| Percentage of neck infection . . . . | 18·1 | 21·1 | 22·9 | 36·9 |
| Yield per acre (lb.) . . . . . | 1365 | 1235 | 1194 | 878 |
| % increase in yield over control . . . | 55·34 | 40·59 | 35·95 | |

## MISCELLANEOUS

I. *Maximum yield potential.*—As has been stated in the previous reports, this permanent experiment was designed to determine the extent to which rice yield can be stepped up by adopting all the departmentally recommended methods of cultivation. On the 4·8 acres of land reserved for this work, *Dhaincha,* which gave an estimated yield of 5750 lb. of green matter, was grown and ploughed in and the area planted to variety BAM 9. As the field could not be easily drained, fertilizing with ammonium sulphate was dropped this year. Mean yield of 3086 lb. of grain and 5100 lb. of straw per acre was obtained from the crop this year. Yield for this area, which had remained static at the level of 2600 lb. per acre during the previous years increased by 19 per cent this year. The cost of cultivation for this area was Rs. 137 per acre and the value of grain and straw obtained from an acre, at the prevailing market rates, was Rs. 359, thus giving a net profit of Rs. 222 per acre.

II. *Maximisation of crop yields by heavy manuring.*—This new experiment was undertaken to determine the maximum yield that can be obtained by heavy manuring and was conducted in an acre of land planted with the variety BAM-9 9″ × 9″ spacing with 2-3 seedlings per hole. The manuring schedule adopted is given below:—

Green manuring with *Dhaincha* at 200 lb. of green matter per acre, 15 tons of municipal compost as basal dressing, bone-meal at 5 cwt. per acre applied before the first ploughing. To 5 out of the 10 plots in the experiments ammonium phosphate and super-phosphate were also applied in the form of pellets placed 2 inches deep in the soil a fortnight before flowering. Plots receiving this treatment lodged prematurely in spite of topping. The yield obtained from the different treatments was of more or less the same order. The crop yielded 2952 lb. of grain and 6300 lb. of straw per acre. Due to lodging there was pronounced unsetting of grain, resulting in 6·5 per cent chaff. The experiment will be repeated next season with modifications designed to arrest the rank vegetative growth obtained this year.

III. *Optimum time of planting of the common improved varieties.*—This experiment with T1145 and T90 was continued on the same lines as in previous years. The results obtained with T1145 confirmed the previous findings that plantings of this variety can be delayed upto about 9th August without affecting the yield of grain and 40 days old seedlings were better suited for planting than 30 days old seedlings.

In the case of T90 planting, last year it was found that later plantings gave as good a yield as the earlier plantings. This year also the plantings upto 9th August did not depress the yield, but the yields decreased progressively as the planting was delayed.

IV. *Green manuring.*—With the object of testing on a large scale the efficiency of green manuring practices with and without fertilizers, an experiment with the following 9 treatments was conducted.

$T_1$ = *Dhaincha* crop (30 lb. seed rate) raised early and ploughed in before transplanting in *kharif* season.

$T_2$ = *Dhaincha* (30 lb. seed rate) sown mixed with rice in the *kharif* season and *bushening* the crop.

$T_3$ = Broadcast (80 lb. seed rate) without any manuring.

$T_4$ = Broadcast rice (80 lb. seed rate) fertilized with 100 lb. of super-phosphate before sowing.

$T_5$ = Broadcast rice (80 lb. seed rate) fertilized with 100 lb. of ammonium sulphate per acre ploughed before sowing.

$T_6$ = *Dhaincha* (30 lb. seed rate) and rice sown mixed and fertilized with 100 lb. ammonium sulphate per acre before sowing.

$T_7$ = *Dhaincha* (30 lb. seed rate) and rice (80 lb. per acre) sown mixed and fertilized with 100 lb. ammonium sulphate plus 100 lb. super-phosphate per acre before sowing.

$T_8$ = *Dhaincha* (30 lb. seed rate) and rice sown mixed and fertilized with 100 lb. super-phosphate per acre.

$T_9$ = *Transplanted rice without manuring.*

The yield data are given below :—

| | Treatments | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | $T_6$ | $T_7$ | $T_8$ | $T_9$ | C.D.5% |
| Yield lb./acre . . | 2590 | 2260 | 1610 | 1750 | 2380 | 1860 | 1870 | 1780 | 1970 | 186·0 |
| % on control ($T_3$) . | 160·8 | 140·3 | 100·0 | 108·6 | 147·8 | 115·5 | 116·1 | 110·5 | 122·3 | |
| % on control ($T_2$) . | 114·6 | 100·0 | 71·2 | 77·4 | 105·3 | 82·3 | 82·7 | 78·7 | 87·2 | |

It will be seen from the data that the highest yield was obtained with treatment No. 1, *viz.*, growing *Dhaincha* early in the season and ploughing it in before transplanting. The next best yields have been obtained by treatments Nos. 5 and 2, hence it is concluded that manuring practices as adopted in treatments Nos. 1, 5 and 2, should be followed. Other conclusions for the above experiment are—

(i) Transplanting is superior to broadcasting ;

(ii) The practice of sowing rice mixed with *Dhaincha* and *bushening* the crop is better than transplanting rice without manuring ;

(iii) The treatment of sub-surface application of ammonium sulphate (dry) to the soil with broadcast rice gives better yield than "broadcasting rice without manuring" and 'transplanting without manuring' respectively;

(iv) With green manuring of the crop, application of ammonium sulphate at any stage appears unnecessary. In fact this practice has a depressing effect on the yield ;

(v) The application of super-phosphate does not increase the yield.

V. *Crop sequence in double cropped lands.*—As in last year the following 7 systems of cropping were tried:—

(i) Jute (*kharif*) followed by green manure and then by summer rice in January—April ;

(ii) Short duration rice (*kharif*), fallow in October—January and short duration rice in January—April ;

(iii) Short duration rice (*kharif*) followed by green manure crop and then by summer rice in January—April ;

(iv) Long duration rice (T1242) in *kharif* followed by a short duration rice crop in January —April ;

(v) Green manuring followed by long duration rice (T1242) in *kharif* and then short duration rice crop in January—April;

(vi) Medium duration crop (T1145) in *kharif* followed by short duration crop in January—April ;

(vii) Green manuring followed by medium duration rice (T1145) in *kharif* and then short duration crop in January—April.

The short duration rice varieties were Ch.47 in the *kharif* season and Co.13 in the January—April season. The results show that the highest yield was obtained with treatment No. iv (*viz.*, growing long duration rice crop followed by a short duration rice crop), next in order of merit were treatments Nos. v, vi and vii.

VI *Seed rate.*—With the object of finding out the optimum seed rate for broadcasting rice, four seed rates, *viz.*, 40, 60, 80 and 100 lb. per acre were tested. The seed was broadcast mixed with *Dhaincha* seed at 15 lb. per acre.

The restults show that the highest yield was obtained with 80 lb. seed rate followed by 100 lb. seed rate. The field conditions under which this experiment was carried out were not satisfactory and the experiment will be repeated next year.

VII. *Seed Supply.*—1,20,027 lb. of seed of varieties, T1242, T90, BAM9, T141 and T1145 were made available for distribution.

VIII. *Intensive Cultivation Centre.*—Propaganda and demonstration in methods of cultivation and distribution of improved seed were continued in the intensive cultivation centre and the following items of work carried out in the eight villages concerned :—

(i) 600 mds. seed of improved varieties was distributed to cover an area of about 600 acres ;

(ii) 50 mds. of *Dhaincha* seed was distributed, and the practice of sowing rice seeds mixed with *Dhaincha* at 15 lb. per acre advocated. An area of 250 acres was sown under this practice ;

(iii) The practice of growing a green manure crop in May-June and ploughing it in and transplanting was demonstrated ;

(iv) Growing of green manure plants as *Theprosia Candida* on the field bunds was popularised with the object of getting green leaf material for the rice crop ;

(v) With the object of growing *Dhaincha* for seed purpose, planting of *Dhaincha* plants, 3 feet apart, on the field bunds during the *bushening* operation was advocated ;

(vi) Use of iron ploughs and wet land puddlers for efficient puddling of the soil was demonstrated ;

(vii) Growing of second crop of rice was demonstrated in 31 acres of land ;

(viii) *Taccavi* loans to the extent of Rs. 46,686 were arranged for purchasing of ammonium sulphate by the cultivators and also compost and seed for second crop ;

(ix) About 200 acres of potato crop was fertilized with ammonium sulphate, which resulted in additional production of 4000 mds. of potato ;

(x) Eight agricultural associations were formed in the centre.

## TRAINING

Shri A. K. Gupte and Shri P. Y. Shendge of the Bombay Department of Agriculture, Bombay State, and Shri Sohan Singh of the Department of Agriculture, Punjab, were given training in rice breeding and genetics during the 1951-52 crop season.

## PUBLICATIONS

1. Ramiah, K., Vachhani, M. V., and Abichandani, C. T. (1951). A rational method of applying sulphate of ammonia to rice. *Curr. Sci.* **20** : 227-28.

2. Abichandani, C. T. and Ramiah, K. (1951). Treatment of rice seed in nutrient solutions as a means of increasing yield. *Curr. Sci.* **20 :** 270-71.

3. Vachhani, M. V. (1952). Fertilizer use for stepping up rice production. *Indian Farming* **II : 28.**

4. Abraham, T. P. and Mohanty, G. C. (1952). Assessment of response to ammonium sulphate in cultivators fields for rice crop. *Quarterly Bulletin of Statistics.* **IV**, No. 2, Govt. of Orissa.

5. Ramiah, K. and Abraham, T. P. (1952). Manuring of rice in India by R. L. Sethi, revised and brought up-to-date. Bull. No. 38, I.C.A.R.

6. Ghose, R. L. M. and Butany, W. T. (1952). Studies on the inheritance of some characters in rice (*O. sativa*) *Indian J. Genet and Pl. Breed.* **12** : 25—30.

## PROGRAMME OF WORK FOR 1952-53

### Agronomy Division

I. Co-ordinated yield trials of local and introduced varieties in the States and at the Institute.

II. Study of the response of varieties to manuring.

III. Determination of the optimum dose, time and method of application of manures and fertilizers and residual and cumulative effect on the soil fertility.

IV. Study of the relative efficiency of various nitrogenous fertilizers.

V. Trials of suitable varieties for double cropping.

VI. Study of rotation of groundnut with rice.

VII. Study of the efficiency of various herbicides for control of weeds in the rice fields and to determine the optimum time and method of their application.

VIII. Trial of small machines for rice cultivation and processing.

*Statistics*

I. Application of discriminant function for selection in segregating progenies.

II. Sampling investigations.

III. Border effect in verietal and manurial trials.

### Botany Division

I. *Breeding*

Maintenance and study of genetic stocks.

Breeding for higher yield by—

(i) Introduction.

(ii) Hybridization between *japonica* and *indica* groups.

(iii) Within *indica* groups.

Breeding for high fertility soil conditions.

Breeding for upland conditions.

II. *Breeding Technique*

Value of secondary selections

III. *Genetics*

Inheritance of quantitative characters:—

(i) Grain size.

(ii) Plant height.

(iii) Tiller number.

Inheritance of pigmentation pattern as well as other morphological character such as auricle, glume, etc.

Genetics of sterility.

IV. *Cytogenetics*

Cytogenetical basis of sterility in *japonica* × *indica* crosses

Production of polyploids particularly in the sterile hybrids between *japonica* × *indica* crosses.

V. *Physiology*

Response of varieties to drought.

Response of varieties to photoperiod.

CHEMISTRY DIVISION

I. Investigations on the need of micro-nutrients.

II. Trials of sub-surface (deep) placement of nitrogenous and other fertilizers as well as the study of effect of soaking seed in the solution of chemicals on yield.

III. Investigations on the applications of Phosphates and their availability.

IV. Investigations on losses of lime, Mg, $K_2O$ phosphates and nitrogen due to leaching and continuous application of sulphate of ammonia and other fertilizers.

V. Investigations on methods of analysis nutrients in the wet and puddled soils.

ENTOMOLOGY DIVISION

I. Study of reactions of genetic stocks to pests.

II. Varietal susceptibility and agronomic practices in relation to pests in general and borers and gall fly in particular.

III. Estimation of loss due to pests, particularly *Hispa Schoenobious* and *Pachydiplosis* in the field and *Sitotroga Calandra* and *Tribolium* in the stored grain.

IV. Trial of insecticides, both proprietary and indigenous.

V. Study of the alternate hosts of the major pests.

VI. Collection of parasites with a view to utilising them for biological control.

VII. Bionomics of *Pachydiplosis* and *Schoenobious.*

FARM DIVISION

I. Maintenance of nucleus seed of improved paddy varieties.

II. Determination of the optimum time of planting for the popular local strains, *viz.*, T.1145 and T.90.

III. Determination of the crop sequence in double cropped lands.

IV. Large-scale field trial of green manuring practices with and without fertilizers.

V. Maximisation of crop yield by heavy manuring.

VI. Demonstration and Propaganda in the Intensive Cultivation Centre.

## Mycology Division

I. Study and estimation of resistance to diseases, mostly Blast and *Helminthosporium*, in the collection under genetic stock.

II. *Helminthosporium*

(i) Study of the relative resistance of selected varieties under natural and artificial infection.

(ii) Investigation of collateral hosts—Identification of pathogen and cross inoculation studies.

(iii) Indentification and estimation of air-borne conidia over rice fields.

(iv) Estimation of loss due to diseases.

(v) Studies on the etiology.

III. *Blast*

(i) Varietal susceptibility trials of seedlings.

(ii) Effects of different levels of organic and inorganic N on incidence of blast.

(iii) Effect of spraying with fungicides on the incidence of blast.

(iv) Estimation of loss in yield due to blast.

# STAFF (1951-52)

| | |
|---|---|
| Director | Shri K. Ramiah, M.Sc., Dip-in-Agri. (Cantab.), F.A.Sc., F.N.A.Sc., F.N.I., L.Ag. Retired 1st October, 1951. |
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| Research Asstt. | Shri C. N. Relwani, B.Sc. (Agri.). |
| **Mycology Div.** | |
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| Asst. Mycologist | Shri Durgadas Ganguly, M.A. |
| Research Asstt. | Shri G. H. Chandwani, B.Sc. (Agri.). |

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